

## CLAIMS

We claim:

1. A system for printing simultaneously on both sides of the page in a printer by using at least one printing element on each side of the paper, without the need for conveyor belts, without the need for stretching the paper between two sets of pairs of rollers and printing between them, without the paper having to make a U-turn around the 2<sup>nd</sup> printing element, and without the need to base the stabilization on continuous paper, and wherein the printing elements are part of at least one of: A printer, a Fax machine, a photocopier, and any machine that uses printing elements.
2. The system of claim 1 wherein said printer is at least one of an inkjet printer and a solid ink printer that doesn't use a drum, and at least two printing heads are used – at least one on each side of the page.
3. The system of claim 2 wherein at least one of the following features exist:
  - a. Said heads are moving in a synchronized manner sideways at the same time.
  - b. Said heads move at opposite sideways directions.
  - c. Said heads each have also at least one moving element that touches the paper as they move, so that the element from both sides of the paper help stabilize the area of the paper being printed upon.
  - d. Said heads can move sideways independently from each other.
  - e. At least one roller on each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, in order to stabilize the paper.
  - f. At least one roller at each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, in order to stabilize the paper.
  - g. At least one roller at each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, and the rollers closer to the position of the printing heads exert stronger force than the rollers farther from the heads, in order to stretch the paper as it reaches the printing position.
  - h. Elongated printing heads are used, one for each color, but they are not the full width of the paper and they move sideways.

- i. Moving non-elongated printed heads are used, one for each color, but they are spread in the direction of the movement of the paper instead of sideways.
  - j. More than 4 basic color heads are used apart from black, in order to further improve the percent of covered color combinations.
- 4. The system of claim 2 wherein the printing heads are stationary elongated heads instead of the normal moving heads, so that each color has it's own elongated printing head, and said elongated print heads are at least one of next to each other and spread with a noticeable gap from each other.
- 5. The system of claim 4 wherein said elongated stationary heads are implemented by at least one of:
  - a. Using at least two piezoelectric elements in each elongated head and creating an interference between at least two mechanical resonance waves created by making the various piezoelectric elements vibrate at certain frequencies and strengths.
  - b. Using at least two magnetic and electromagnetic elements in each elongated head and creating an interference between at least two mechanical resonance waves created by making the various electromagnetic elements vibrate at certain frequencies and strengths.
  - c. Using a matrix of small piezoelectric elements throughout the length of the head.
  - d. Using a matrix of small heat elements throughout the length of the head.
  - e. Using more than 4 elongated color heads apart from black, in order to further improve the percent of covered color combinations.
- 6. The system of claim 1 wherein said printer is a laser printer and at least one of the following configurations exists:
  - a. At least two cartridges are used next to each other so that the drums are closely facing each other and the paper can pass between at least two drums at the same time.
  - b. At least one cartridge is used to deal with both sides of the paper, so that the paper passes between at least one pair of drums that are connected to the same cartridge.
- 7. The system of claim 1 wherein the printer is a laser printer and at least one of the following features exists:

- a. The paper is given a stronger electric charge and the toner powder on both sides of the paper is given a weaker electric charge in order to avoid rejection between the powders from both sides of the paper.
  - b. The element that fixes the toner to the paper by heat and pressure is as close as possible to the drums in order to avoid smearing.
8. The system of claim 1 wherein said printer is also capable of automatically binding pages together in a book-like form, and said binding is based mainly on gluing the separate pages together at one of their ends.
9. The system of claim 8 wherein said gluing is based on at least one of:
  - a. Pouring the glue in a container.
  - b. Feeding a special cover around the book which has the glue on the inner back strip.
  - c. Covering each page with an appropriate shape and amount of at least one of plastic and adhesive material at the appropriate edge.
10. The system of claim 1 wherein said printer is also capable of automatically binding pages together in a book-like form and said binding is based mainly on mechanically joining the separate pages together.
11. The system of claim 10 wherein at least one of the following features exists:
  - a. The pages are first joined in groups of folded papers, and said groups are later joined together by at least one of mechanical means and gluing them together.
  - b. Pages of different sizes have to be already in the right size before inserting them into the printer.
  - c. The printer can cut the pages to smaller parts before printing on them.
  - d. The printer can cut the pages to smaller parts after printing on them by first folding them properly and cutting at the fold.
  - e. The pages are first joined in groups of folded papers, and said groups are later joined together, and said folding is done by at least one of:  
Inserting a moving element in a slit in a way that pulls and folds the papers in the middle, and Moving part of the tray around a hinge at the center with a horizontal element applied from above the papers, parallel to the hinge.
  - f. The pages are first joined in groups of folded papers, and said groups are later joined together, and more than one folding stage can be done,

so that at least all the folds before the last fold are followed by cutting the papers at the position of the fold.

12. A method for printing simultaneously on both sides of the page in a printer by using at least one printing element on each side of the paper, without the need for conveyor belts, without the need for stretching the paper between two sets of pairs of rollers and printing between them, without the paper having to make a U-turn around the 2<sup>nd</sup> printing element, and without the need to base the stabilization on continuous paper, and wherein the printing elements are part of at least one of: A printer, a Fax machine, a photocopier, and any machine that uses printing elements.
13. The method of claim 12 wherein said printer is at least one of an inkjet printer and a solid ink printer that doesn't use a drum, and at least two printing heads are used – at least one on each side of the page.
14. The method of claim 13 wherein at least one of the following features exist:
  - a. Said heads are moving in a synchronized manner sideways at the same time.
  - b. Said heads move at opposite sideways directions.
  - c. Said heads each have also at least one moving element that touches the paper as they move, so that the element from both sides of the paper help stabilize the area of the paper being printed upon.
  - d. Said heads can move sideways independently from each other.
  - e. At least one roller on each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, in order to stabilize the paper.
  - f. At least one roller at each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, in order to stabilize the paper.
  - g. At least one roller at each side of the paper is used before the paper reaches the printing heads very close to the position of the printing heads, and the rollers closer to the position of the printing heads exert stronger force than the rollers farther from the heads, in order to stretch the paper as it reaches the printing position.
  - h. Elongated printing heads are used, one for each color, but they are not the full width of the paper and they move sideways.
  - i. Moving non-elongated printed heads are used, one for each color, but they are spread in the direction of the movement of the paper instead of sideways.

- j. More than 4 basic color heads are used apart from black, in order to further improve the percent of covered color combinations.
15. The method of claim 13 wherein the printing heads are stationary elongated heads instead of the normal moving heads, so that each color has it's own elongated printing head, and said elongated print heads are at least one of next to each other and spread with a noticeable gap from each other.
16. The method of claim 15 wherein said elongated stationary heads are implemented by at least one of:
- a. Using at least two piezoelectric elements in each elongated head and creating an interference between at least two mechanical resonance waves created by making the various piezoelectric elements vibrate at certain frequencies and strengths.
  - b. Using at least two magnetic and electromagnetic elements in each elongated head and creating an interference between at least two mechanical resonance waves created by making the various electromagnetic elements vibrate at certain frequencies and strengths.
  - c. Using a matrix of small piezoelectric elements throughout the length of the head.
  - d. Using a matrix of small heat elements throughout the length of the head.
  - e. Using more than 4 elongated color heads apart from black, in order to further improve the percent of covered color combinations.
17. The method of claim 12 wherein said printer is a laser printer and at least one of the following configurations exists:
- a. At least two cartridges are used next to each other so that the drums are closely facing each other and the paper can pass between at least two drums at the same time.
  - b. At least one cartridge is used to deal with both sides of the paper, so that the paper passes between at least one pair of drums that are connected to the same cartridge.
18. The method of claim 12 wherein the printer is a laser printer and at least one of the following features exists:
- a. The paper is given a stronger electric charge and the toner powder on both sides of the paper is given a weaker electric charge in order to avoid rejection between the powders from both sides of the paper.

- b. The element that fixes the toner to the paper by heat and pressure is as close as possible to the drums in order to avoid smearing.
- 19. The method of claim 12 wherein said printer is also capable of automatically binding pages together in a book-like form, and said binding is based mainly on gluing the separate pages together at one of their ends.
- 20. The method of claim 19 wherein said gluing is based on at least one of:
  - a. Pouring the glue in a container.
  - b. Feeding a special cover around the book which has the glue on the inner back strip.
  - c. Covering each page with an appropriate shape and amount of at least one of plastic and adhesive material at the appropriate edge.
- 21. The method of claim 12 wherein said printer is also capable of automatically binding pages together in a book-like form and said binding is based mainly on mechanically joining the separate pages together.
- 22. The method of claim 21 wherein at least one of the following features exists:
  - a. The pages are first joined in groups of folded papers, and said groups are later joined together by at least one of mechanical means and gluing them together.
  - b. Pages of different sizes have to be already in the right size before inserting them into the printer.
  - c. The printer can cut the pages to smaller parts before printing on them.
  - d. The printer can cut the pages to smaller parts after printing on them by first folding them properly and cutting at the fold.
  - e. The printer can cut the pages to smaller parts after printing on them by first folding them properly and cutting at the fold, and said folding is done by at least one of: Inserting a moving element in a slit in a way that pulls and folds the papers in the middle, and Moving part of the tray around a hinge at the center with a horizontal element applied from above the papers, parallel to the hinge.
  - f. The printer can cut the pages to smaller parts after printing on them by first folding them properly and cutting at the fold, and more than one folding stage can be done, so that at least all the folds before the last fold are followed by cutting the papers at the position of the fold.



23. The system of claim 1 wherein the printer is a laser printer and at least one of the following configurations is used for supplying the laser beams to both sides of the paper:
  - a. At least two lasers sources are used, one for each side of the paper.
  - b. At least two LED arrays are used, one for each side of the paper.
  - c. At least one laser source is optically split into at least 2 beams, which are then each separately modulated on/off and rotated by their own optical deflector.
  - d. At least one laser source is conducted part of the time by optical means to transfer the light to the other side of the paper, so that part of the rotation of the optical deflector runs the laser light over the appropriate pixel-line on the drum on one side of the paper, and another set of angles of rotation runs the light into the optical relay system which correspondingly diverts the laser light to the appropriate position in the pixel-line on the drum on the side of the paper.
24. The method of claim 12 wherein the printer is a laser printer and at least one of the following configurations is used for supplying the laser beams to both sides of the paper:
  - a. At least two lasers sources are used, one for each side of the paper.
  - b. At least two LED arrays are used, one for each side of the paper.
  - c. At least one laser source is optically split into at least 2 beams, which are then each separately modulated on/off and rotated by their own optical deflector.
  - d. At least one laser source is conducted part of the time by optical means to transfer the light to the other side of the paper, so that part of the rotation of the optical deflector runs the laser light over the appropriate pixel-line on the drum on one side of the paper, and another set of angles of rotation runs the light into the optical relay system which correspondingly diverts the laser light to the appropriate position in the pixel-line on the drum on the side of the paper.
25. The system of claim 1 wherein the paper is held in place also by at least one of:
  - a. Double-sided tracks at the right and left margins of the paper.
  - b. Sets of wheels of which at least some are tilted at the side margins so that the wheels both pull the paper forward and sideways.
  - c. Sets of wheels at the side margins with engraved screw-like spirals so that the wheels both pull the paper forward and sideways.

26. The system of claim 1 wherein the printer is a laser printer and at least one of the following features exists:
- a. If there is no paper, the drums are automatically moved a little away from each other so that they don't touch each other in order not to scratch / damage each other.
  - b. There is a shift between the positions of the two drums, so that the paper does not touch both drums at the same position.
  - c. There is a shift between the positions of the two drums, so that the paper does not touch both drums at the same position, and between the positions of the two drums there is an additional fixing element, so that the powder on each pixel-line of the 1<sup>st</sup> side of the paper is already set when the corresponding pixel-line on the other side of the paper enters the second drum.
27. The system of claim 2 wherein the at least two printing heads are positioned in at least one of the following ways:
- a. The heads are positioned to the right and to the left of the paper instead of one head above the paper and one head below the paper.
  - b. The heads are positioned to the right and to the left of the paper instead of one head above the paper and one head below the paper, and the ink containers are similar to an "L" shape for the left head and opposite "L" shape for the right head, so that the heads are at the horizontal ends of the containers and face each other, and the vertical parts can take advantage of normal gravity to move the ink towards the printing elements of the heads.
  - c. At least one head is above the paper, and at least one head is below the paper and relies on air pressure instead of gravity to direct the ink towards the printing head.
  - d. At least one head is above the paper and at least one head is below the paper and relies on at least one spring instead of gravity to direct the ink towards the printing head.
28. The system of claim 1 wherein the printer is a laser printer and when printing only on one side at least one of the following configurations exists:
- a. All the cartridges in the unused side are automatically moved slightly away from the paper so that it doesn't have to touch it.
  - b. All the drums in the cartridges in the unused side are automatically moved slightly away from the paper so that it doesn't have to touch it.



29. The system of claim 1 wherein the printer is a solid ink printer which first prints to a drum and then transfers the ink to the paper, and at least one of the following features exists:
- At least two drums are used next to each other so that the paper can pass between them at the same time and a separate set of solid inks and printing heads is used with each drum.
  - The element that fixes the ink to the paper is as close as possible to the drums in order to avoid smearing.
  - If there is no paper, the drums are automatically moved a little away from each other so that they don't touch each other in order not to scratch / damage each other.
  - There is a shift between the positions of the two drums, so that the paper does not touch both drums at the same position.
  - There is a shift between the positions of the two drums, so that the paper does not touch both drums at the same position, and between the positions of the two drums there is an additional fixing element such as for example a set of rollers that fix the powder by cold pressure, so that the ink on each horizontal line of the 1<sup>st</sup> side of the paper is already set when the corresponding horizontal line on the other side of the paper enters the second drum.
30. The system of claim 11 wherein the pages are first joined in groups of folded papers, and said groups are later joined together, and said folding is done by inserting a moving element in a slit in a way that pulls and folds the papers in the middle, and at least one of the following features exists:
- Said slit is a little wider on the top of the tray floor than on the bottom of the floor in order to further help guide the sheets or paper smoothly through the slit.
  - After being pushed through the slit the folded bunches of paper enter a tilted smaller container below the first half of the output tray, so that each time after the pushing element moves out, the newly folded group of papers falls to the side, so that the folded groups of paper lie down stacked on top of each other.
  - Staples can be entered into each bunch of folded papers by an additional side element near the slit.
  - For each book a cover of stronger material is first fed into the bottom compartment so that the upper part of the cover is preferably held in parallel to the wall of said bottom compartment that is near the slit and the bottom part in parallel to the floor of said bottom compartment.

31. The system of claim 30 wherein for each book a cover of stronger material is first fed into the bottom compartment, and at least one of the following features exists:
- a. When the moving element pushes down through the slit a folded bunch of papers at the end staples are automatically inserted from below and small sockets at the edge of the moving element cause them to bend and thus stitch the folded bunch of papers together and to the cover.
  - b. The book cover contains at its central fold a stronger strip with small metal elements like staples, so when the moving element pushes down through the slit a folded bunch of papers it presses against these staples at the end and small sockets at the edge of the moving element cause these staples to bend and thus hold the folded bunches of paper at the fold areas.
  - c. The book cover contains at its central fold a stronger strip with small plastic hollow needles containing glue at their edges, so that when pressed by the edge of the moving element they penetrate each bunch of papers at the fold area and the parts containing the glue explode and the glue holds it in the inner part of each fold.
32. The system of claim 11 wherein the pages are first joined in groups of folded papers, and said groups are later joined together, and at least one of the following features exists:
- a. The book cover contains at its central fold a stronger strip with an adhesive material that can attach to the fold areas of the folded bunches of paper by at least one of pressure and heat.
  - b. The printer just creates the folded bunches of pages on top of each other and the user then glues them together and adds the cover then.
33. The system of claim 11 wherein the folding is done by Moving part of the tray around a hinge at the center with a horizontal element applied from above the papers, parallel to the hinge, and at least one of the following features exists:
- a. At each stage of folding an additional bunch of newly printed papers, the previously folded bunches go down one step into a lower compartment.
  - b. The book cover is initially attached at both ends to the two edges of the output tray and, at each stage of folding an additional bunch of newly printed papers, the previously folded bunches go down one step into a lower compartment.

- c. The book cover contains at its central fold a stronger strip with small metal elements like staples, so these staples are bent by pressing the fold against them.
  - d. The book cover contains at its central fold a stronger strip with small plastic hollow needles containing glue at their edges, so that when pressing the fold against them they penetrate each bunch of papers at the fold area and the parts containing the glue explode and the glue holds it in the inner part of each fold.
  - e. Staples are added at the area of the hinge after the folding.
  - f. Staples are added at the area of the hinge after the folding, so that the staples also stitch the book cover directly to each fold.
34. The system of claim 1 wherein the printer is a solid ink printer which first prints to a drum and then transfers the ink to the paper and wherein elongated printing heads are used, and at least one of the following is done:
- a. The ink is heated and liquefied in order to evenly distribute it.
  - b. Elongated printing heads are used with non-elongated solid inks, so that each time only the tip of the ink is melted and the liquid can flow within at least one of the head and an elongated ink buffer near the head to the positions needed.
  - c. Said elongated printing heads are the full width of the paper and are stationary.
  - d. Said elongated printing heads are not the full width of the paper and they do move sideways.
  - e. Moving non-elongated printing heads are used but they are spread in the direction of the movement of the paper instead of sideways.
35. The system of claim 11 wherein the pages are first joined in groups of folded papers, and said groups are later joined together, and wherein a stripe each paper has a stripe of glue on the middle at the area of the fold and after folding bunches of pages together, the glue binds together both the pages within each bundle and the different bundles to each other and to the cover.
36. The system of claim 1 wherein the printer is a laser printer and at least two cartridges are used next to each other so that the drums are closely facing each other and the paper can pass between at least two drums at the same time, and wherein at least one of the following configurations exists:
- a. The cartridges are upright and the drums are at the corners of the cartridges, facing each other, in order to prevent toner from spilling.

- b. The cartridges are a little tilted towards each other so that their drums can come into contact.
  - c. At least one of the drums has a spring in order to improve the contact between the two drums.
  - d. At least one of the cartridges has a spring in order to improve the contact between the two drums.
  - e. A number of toner cartridges are used on each side of the paper for color printing
37. The system of claim 1 wherein the printer is a laser printer and at least one cartridge is used to deal with both sides of the paper, so that the paper passes between at least one pair of drums that are connected to the same cartridge, and wherein a number of double-drum toner cartridges are used for color printing
38. The system of claim 8 wherein said gluing is based on covering each page with an appropriate shape and amount of at least one of plastic and adhesive material at the appropriate edge and wherein at least one of the following:
- a. The pages are already doped in advance with said adhesive or plastic materials.
  - b. Said adhesive or plastic materials are added by the printer to each page after it has been printed upon.
39. The system of claim 1 wherein said printer is a laser printer and wherein at least one of the following:
- a. The toners on both sides of the paper are fixed simultaneously at the same position.
  - b. The toner contains also an adhesive element that makes it stick better to the paper independently of the electrical charge.
40. The system of claim 1 wherein said printer is a laser printer and wherein after the fixing elements that set the toner, the paper moves through a position of another type of printing elements that can add color where needed, and at least one of the following features exists:
- a. Said color printing elements can print on at least one side of the paper.
  - b. Said elements that can add color are at least one of inkjet printing heads, solid ink printing heads, and drums coupled to solid ink printing heads.
  - c. The color printing elements take advantage of the fact that the paper is still hot after exiting the fixing elements that set the toner.

- d. The laser unit and the color printing unit work in coordination so that both units can find the exact same positions on the paper and the pixel sizes and margin sizes are sufficiently similar in both units and take into account already also expansion or contraction of the paper and the printer can divide the black printing and the color printing between them as needed.
- e. When the percent of black in comparison to color on a certain page is below a certain threshold, the printer can preferably automatically decide to use only the inkjet for that page, in order to achieve more precise mixing.
- f. Images and text areas are automatically treated differently, so that the images are automatically assigned to the color printing elements and the text can be printed by one of the units or divided between them.
- g. In areas where there is no color the feeder lets the page move much faster, so that the addition of colors only slows down the printing by a minimum percent.
- h. At least one of the printer, the user, and software using the printer can automatically decide to convert text to black and send it for the laser unit for printing.
- i. The user has the choice of telling the printer to set Off the inkjet part, in which case the printer behaves like a normal laser printer. In all of the above variations, preferably the laser unit is able, when the inkjet option is set to On.
- j. The right-left positioning is done by using at the side margins at least one of tiled wheels and wheels with engraved screw-like spirals wherein the tilt is stronger towards one of the sides and there is a border on that side.
- k. Sensing is done on at least one of the position of the paper margins and the position of the laser printing, by at least one of at least one reference mark in black and at least one UV mark that is done by an element that is always at the same position in the laser unit, and said sensing can be used to correct the position of the paper and/or the position of the printheads and/or to correct it logically by the printheads.

41. A laser printer wherein after the fixing elements that set the toner, the paper moves through a position of another type of printing elements that can add color where needed, and at least one of the following features exists:

- a. Said color printing elements can print on at least one side of the paper.

- b. Said elements that can add color are at least one of inkjet printing heads, solid ink printing heads, and drums coupled to solid ink printing heads.
- c. The color printing elements take advantage of the fact that the paper is still hot after exiting the fixing elements that set the toner.
- d. The laser unit and the color printing unit work in coordination so that both units can find the exact same positions on the paper and the pixel sizes and margin sizes are sufficiently similar in both units and take into account already also expansion or contraction of the paper and the printer can divide the black printing and the color printing between them as needed.
- e. When the percent of black in comparison to color on a certain page is below a certain threshold, the printer can preferably automatically decide to use only the inkjet for that page, in order to achieve more precise mixing.
- f. Images and text areas are automatically treated differently, so that the images are automatically assigned to the color printing elements and the text can be printed by one of the units or divided between them.
- g. In areas where there is no color the feeder lets the page move much faster, so that the addition of colors only slows down the printing by a minimum percent.
- h. At least one of the printer, the user, and software using the printer can automatically decide to convert text to black and send it for the laser unit for printing.
- i. The user has the choice of telling the printer to set Off the inkjet part, in which case the printer behaves like a normal laser printer. In all of the above variations, preferably the laser unit is able, when the inkjet option is set to On.
- j. The right-left positioning is done by using at the side margins at least one of tiled wheels and wheels with engraved screw-like spirals wherein the tilt is stronger towards one of the sides and there is a border on that side.
- k. Sensing is done on at least one of the position of the paper margins and the position of the laser printing, by at least one of at least one reference mark in black and at least one UV mark that is done by an element that is always at the same position in the laser unit, and said sensing can be used to correct the position of the paper and/or the position of the printheads and/or to correct it logically by the printheads.